National Defense Center for Energy and Environment

Small-Scale Waste-to-Energy Technology for Contingency Bases

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Outline

- System of Systems Approach
- Contingency Base Solid Waste Issues
- Solid Waste Management Options
- Waste-to-Energy Technology Evaluation
- Selected Technology
- Demonstration Objectives
- Next Steps
- Contacts & Questions

Applying a System of Systems Approach

- System is greater than the sum of its parts
- Optimizing individual pieces will not necessarily achieve optimization for the system as a whole
  - Purpose-driven
  - Hierarchical
  - Interdependent
  - Interconnected
  - Complex
  - Dynamic

Solid Waste Issues

- Operational and maintenance burdens
- Regulatory and other compliance issues
- Safety and health issues
- Security issues
- Natural infrastructure demands
- Greenhouse gas emissions
- Tipping, transportation, and contractor costs

Waste = Liability

Contingency Base Non-Hazardous Solid Waste Management Options

Option	Advantages	Disadvantages
Burial Landfill	Low Cost Low Maintenance Expedient, No Sorting	Large Footprint Impacts to Host Nation Leachate + Residual Liability
Open Pit Burn	Low Maintenance Expedient, No Sorting	High Cost – Fuel Large Footprint Impacts to Host Nation + Camp Leachate + Air Emissions Ash Sampling
Incineration Burn Box	Higher Burn Temperature Smaller Footprint No Sorting	High Cost – Fuel Mobility Issues Scaling and Capacity Issues Ash Sampling
Incineration Two Stage Burn	Higher Burn Temperature Smaller Footprint No Sorting	High Cost – Capital and Fuel Scaling and Capacity Issues
Waste-to-Energy	Higher Burn Temperature Useful By-Product Low Fuel Demand	High Cost – Capital High Maintenance, Operator Skill Level Requires Waste Sorting/Pre-processing Scaling and Capacity Issues Technology Readiness Issues
Composting	Useful By-Product Low Cost Low Energy Demand	Requires Waste Sorting Suitable for Certain Organic Wastes Only Scaling and Capacity Issues

Waste-to-Energy Options (Small- to Mid-Size Contingency Base)

Option	Advantages	Disadvantages
Incineration with Heat Capture	Low Capital Cost Low Maintenance Expedient, No Waste Sorting Technology Readiness Level	High Fuel Demand Water Required Steam Infrastructure Required Air Emissions
Gasification	Power Generation Low to No Fuel Demand Minimal Air Emissions	High Capital Cost Waste Sorting and Pre-processing High Maintenance and Operator Skill Level Technology Readiness Level
Plasma	High Burn Temperature No Sorting Lower Air Emissions Can Handle Hazardous Waste	High Cost – Capital and Fuel Mobility Issues Not Net Energy Positive Technology Readiness Level
Pyrolysis	Power Generation Low to No Fuel Demand Liquid Distillates	Limited Commercial Available Mobility Issues Waste Sorting and Pre-processing Additional Waste Processing Technology Readiness Level

Desired Contingency Base Characteristics

- Increased flexibility in base camp operations
- Decreased construction/de-construction requirements
  - Time, material, equipment, personnel
- Improved operations management
  - Power, water, waste
- Improved design of major utility infrastructure
- Improved Environmental, Safety, and Occupational Health (ESOH) elements

Focus of NDCEE effort: Small- to Mid-size Contingency Bases

Technology Evaluation Criteria

- Throughput Capacity
- Mobility
- Capital Costs
- Personnel Requirements
- Technical Readiness
- Maintainability/Reliability
- Procurement Lead Time

Selected Waste-to-Energy Technology

- All Power Labs 20kW Power Pallet
- Consumes 50lbs of waste per hour
- Full gasification system
- Costs $26K
- GM Industrial Engine (GM 4 Cylinder, 3.00 L)
- MeccAlte Generator Head
- Imbert type downdraft reactor
- Digital controller
- Fits on 4 ft pallet
- Operational dimensions 48" x 50" x 84”
- Open-source, easy to program operating software

Feed System

A mechanized auger feeds the waste into the gasifier

The feed hopper is available in 55-gallon stainless steel with a port window

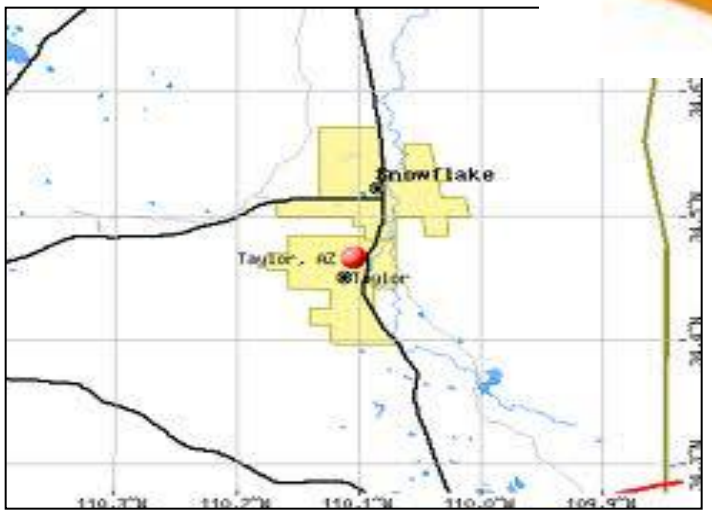
Demonstration Objectives

- Mobility – set up time/requirements
- Manpower – operator capabilities and time required
- Material Handling – which waste can it accommodate; how much sorting and pre-processing is required?
- Energy Generation Capability – how does this vary with waste stream?
- O&M Requirements
- Site Requirements

WEEK	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	TRAVEL	Set-up of Power Pallet	Curing & Training	Shredded Waste Trials (No plastic)			
2		Mixed Waste Trials Briquettes & Shredded		Mixed Waste Trials Briquettes (20% plastic)			
3		Shredded Waste Trials (plastic)		Contingency	Tear Down	TRAVEL	

Demonstration Site: Snowflake, AZ

- Waste Hauler – providing waste for demonstration that matches estimated contingency base composition
- Incineration permitted by State Regulatory Agency

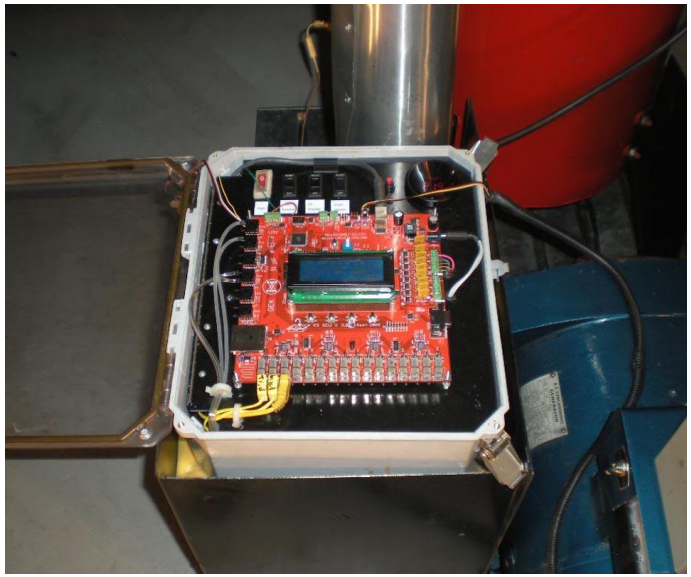


Estimated Waste Characterization

Waste Category	Waste Material	Percentage of Waste by weight
Plastics (7%)	PETE	3.0%
	PP	1.0%
	PVC	1.0%
	PS	1.0%
	PU (foams)	0.5%
	ABS (electronics)	0.5%
Wood (7%)	Treated (Pallets)	4.0%
	Untreated	3.0%
Metals (3%)	Aluminum/Tin	1.0%
	Iron/Steel	1.0%
	Copper Wire, Insulated	1.0%
Misc. Combustibles (80%)	Fabrics, synthetic	5.0%
	Fabrics, natural	10.0%
	Canvas, military*	2.5%
	Cardboard	7.5%
	Paper	25.0%
	Rubber	2.5%
	Wet food waste (slop)	25.0%
	Oils and Greases	2.5%
Dunnage (3%)	Glass	2.0%
	Building Materials	1.0%
TOTAL:		**100%**

Data Collection-Process Control Unit

- Temperature
- Pressure
- Gas Flow Rate
- Oxygen Sensor



The Process Control Unit provides instrumentation and automation needs for thermal conversion. The combination of electronic control and waste heat recycling is the basis of the higher combustion temperature possible with this technology. These variables are important for improved tar conversion, increased tolerance for high moisture fuels, and increased gasifier efficiency.

Data Collection-Gas Composition

- Carbon Monoxide-CO
- Carbon Dioxide-CO_2
- Hydrogen-H_2
- Oxygen-O_2
- Methane-CH_4
- Higher (aromatic) hydrocarbons-C_nH_m

Gasboard 3100

Data Collection-Financial Analysis

- Data Collection
  - Solid waste volume reduction
  - Response to waste streams
    - biomass, refuse-derived fuel, shredded waste
  - Operation and maintenance requirements
  - Power generation
  - Problems encountered
- Cost Benefit Analysis
  - Time and labor required to set up, operate, maintain and break down
  - Waste pre-processing requirements
  - Capital costs to include any additional equipment required

Next Steps

Short Term

- Evaluate if Small-Scale Waste-to-Energy systems can be used to divert waste generated from deployed forces into energy for use by contingency bases
  - Using available waste stream with minimal sorting or pre-processing
  - Using existing power infrastructure

Long Term

- Evaluate if Small-Scale Waste-to-Energy systems can be paired with waste densification units to provide complete waste conversion systems

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